

REMARKS

Reconsideration of the application is respectfully requested in view of the following reasons:

Amendment to the Claims

The Examiner states that Claim 62 is rejected under 35 U.S.C. 112. In response, applicant has amended base Claim 51 to overcome the rejection. Especially, the applicant thinks that any etching process has a predetermined etching selectivity thereof. The Examiner also states that Claims 51 and 63 are rejected under 35U.S.C. §102(e). Therefore, Claim 51 is amended in order to present a better and proper form supported by the specification and figures. The original Figures and the original specification as originally filed support all amendments to Claim 51. It is respectfully submitted that these changes are clearly supported by the description of the application, and therefore do not constitute new matter. Therefore, it is believed that the Claims 51 to 63 should be in immediate condition for allowance.

Rejection of Claim 62 Under 35 U.S.C. §112, second paragraph

Claim 62 stands rejected under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

According to this Office Action, the Examiner states that in Claim 62 "the etched selectivity" has insufficient antecedent basis for this limitation in the claim. Applicant emphasizes that every etching process inherently has an etching selectivity to a selectively etch various material, that is, the etching selectivity is a property of the etching process. However, in Claim 62, the recitations as the examiner stated in the Office Action have been corrected to correspond with the requirements of the examiner. Thus, it is respectfully submitted that amended Claim 62 is in condition for allowance. Reconsideration and withdrawal of the rejections under 35 U.S.C. §112 is respectfully requested.

Rejection of Claims 51 and 63 Under 35U.S.C. §102(e)

Claim 51 stands rejected under 35 U.S.C. §102(e) as being anticipated by Chen et al. (U.S. Patent, No. 6,080,663), and further, Claims 51 and 63 stand rejected under 35 U.S.C. §102(e) as being anticipated by Jeng et al. (U.S. Patent, No. 6,372,660).

This rejection is respectfully traversed on the basis that Chen and Jeng do not disclose the features of the present invention. Chen discloses a method for forming the dual damascene by an ion implantation. In Chen, the ion implantation 210 is performed to form a doped region 212 in the predetermined position for forming the dual damascene opening, wherein the doped region 212 has a larger etching rate than the other part of the dielectric layer 204 (col.3 lines 57~59, col.4 lines 8~11), the larger etching rate of the doped region 212 implies that the doped region 212 is a weakened region, otherwise the dual damascene opening cannot be formed (FIG.2B to FIG.2D). On the contrary, in this invention, the

doped regions 440/540 are dense regions relative to other parts of the dielectric layers. Furthermore, the etching rate of the doped regions 440/540 must be lower than that of the other parts of the dielectric layers 450/410 and 510, as shown in FIG. 4B-4C and FIG. 5B-5C. Therefore, the principle as described by Chen is different from the present invention.

Moreover, Jeng also discloses a method for forming the dual damascene with a masked implantation. In Jeng, as shown in Fig. 5B-5C, the portion of the dielectric layer 510 with the top of implantation region 540 would **not be etched** during the etching process, but the portion of the dielectric layer 510 without the top of implantation region 540 would **be etched** until the surface of substrate 500 is exposed for patterning the dual damascene. The applicant concludes that the masked implantation 530/630 is performed to form the dense regions 540/640 as the etched barrier layers that are the etched stop layers (col.5, lines 30-34; and col.5, lines 63-65). On the contrary, referring to the FIG. 4B-4C and FIG. 5B-5C of the present invention, the ion-implanted layer 440/540 is utilized to retard the etching rate such that the ion-implanted layer 440/540 is etched slowly during the etching process so as to form the trench region. It is noted that the trench region in Jeng is formed in the dielectric layer 550, but both dense regions 540/640 are not utilized to form the trench region. In Jeng, the dense regions 540/640 are utilized to form the via in the dielectric layer 510, so the process result is different between this citation and the present invention. In other words, if the dense regions 540/640 in Jeng are removed, the dielectric layers 510/610 will be lost during the etching process, and then the dual damascene

opening cannot be formed. On the other hand, in Chen and Jeng, their first photoresist layer is used to form the via region, and the second photoresist layer is used to form the trench and the via hole, but this invention utilizes the first photoresist layer to form the trench region and the second photoresist layer to form the via hole and the trench. Therefore, Jeng is different from the present invention.

Obviously, for the foregoing reasons, it is believed that the accumulation of elements from cited sources in such diverse arts is insufficient to present a prima facie case of obviousness. There is no reason, suggestion, or motivation in the cited prior art, whereby a person of ordinary skill would not modify Chen or Jeng by any citation to perform the process of the present invention. For these reasons, and for the reasons discussed above, it is respectfully submitted that Chen and Jeng do not anticipate Claims 51 and 63 of the present invention and withdrawal of the rejection under 35 U.S.C. §102(e) is respectfully requested.

Rejection of Claims 52-62 Under 35U.S.C. §103(a)

Claim 52 stands rejected under 35 U.S.C. §103(a) as obvious over Jeng in view of Muller (U.S. Patent, No. 6, 207, 517); and further, Claims 53-62 are rejected under 35 U.S.C. §103(a) as being unpatentable over Jeng and Muller as applied to Claims 51-52 above and further in view of Wu (U.S. Patent, No. 6, 127, 247).

This rejection is respectfully traversed on the basis that there is no teaching, suggestion or incentive supporting the citation,

predominantly because the citations disclose methods for forming a dual damascene that are different from this invention. The method for forming the damascene region, or implanting process, or the opening of the dual damascene that is formed by ion-implantation twice are not features of the present invention. The features of the present invention disclose formation of a dense region with lower etching rate in the dielectric layer in order to protect the dielectric layer under the dense region from etching process, so as to form an opening of the dual damascene after etching the vertical that does not need to be dense. This is not shown in all citations.

In Jeng's citation, the dense region 540/640 is utilized to be the etching stop layer for protecting the dielectric layer 510/610; but in Muller's citation, he utilizes various ion-implantation and depths to weaken the bonding structure in the dielectric layer for forming dual implanting region, especially the ion-implanted region 40/40' can be formed as the loose region (col. 5, lines 10-11). On the other hand, referring to the FIG.1B-1C in Muller, an etching process is performed to remove the region with high etching rate that is implanted to form dual damascene, that is, the etching rate in the ion-implanted region 40/40' must be higher than the un-implanted region--otherwise the dual damascene cannot be formed. On the contrary, this invention utilizes ion-implantation to form a dense region with lower etching rate to generate a greater etched selectivity between implanting and un-implanted regions in dielectric layer, so as to remove the un-implanted region with low etching rate until the implanted region is depleted during the etching process, that is, the implanted region of the present invention is an etched buffer layer, whereby an opening of the dual damascene is formed. Obviously, the dual damascene structure with a dense region

and a non-dense region in this invention is different from the dual damascene structure with two implanted regions taught by the citations. Specially, these citations do not disclose that the opening of the dual damascene is formed by the buffer layer of the ion-dense region.

Referring to the FIG.4, 7 and 8 in Wu, Wu teaches that the P-wells 24, 28 and N-wells 30 are formed during the plurality of ion-implanting processes, so the main subject matter in this citation is to form the well structure, but Jeng or Muller are to form the dual damascene structure. Therefore, the process field is very different among these citations, Jeng or Muller and Wu. Therefore, a person having ordinary skill in the art cannot obtain this invention by combining these citations. Moreover, claims 52 to 63 are dependent on claim 51, so claims 52 to 63 will be allowed with claim 51. Withdrawal of this rejection is respectfully requested, and allowance of Claims 52 to 63 is earnestly solicited.

Therefore, for the reasons discussed above, applicant respectfully submits that the Claims 52 to 63 of this invention are patently distinguished over all cited references. Withdrawal of this rejection under 35 U.S.C. §103(a) is respectfully requested, and allowance of Claims 52 to 63 is earnestly solicited.

Conclusion

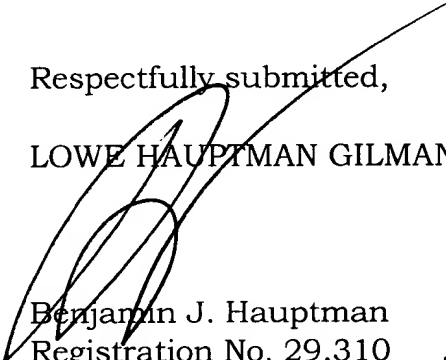
In light of the above amendments and remarks, applicants respectfully submit that all pending claims 51 to 63 as currently presented are in condition for allowance and hereby respectfully request

reconsideration. Applicant respectfully requests the Examiner to pass the case to issue at the earliest convenience. Having thus overcome each of the rejections made in this Office Action, withdrawal of the rejections and expedited passage of the application to issue is requested.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 07-1337 and please credit any excess fees to such deposit account.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Claims 51 and 62 are amended as follows:

51. (Amended) A method for forming a dual damascene opening, comprising:

providing a substrate with a dielectric layer thereon;

providing a first patterned photoresist on said dielectric layer to expose a first portion of said dielectric layer [at which at least a portion of trench is to be formed];

implanting ions into said [exposed] first portion of said dielectric layer in a depth of part of the thickness under the masking of said first patterned photoresist so as to form a dense region [having an etching rate lower than that of said dielectric layer] in said first portion of said dielectric layer;

removing said first patterned photoresist;

providing a second patterned photoresist on said dielectric layer, said second patterned photoresist defining an etching opening for exposing at least part of said dense region and a [region] second portion of said dielectric layer [in which a via hole is to be formed];

performing an etching process whose by said second patterned photoresist to etching said dielectric layer under said etching opening until exposing said substrate, wherein the etching rate of said dense region is lower than said second portion of said dielectric layer, whereby a trench region is formed in said dense region and a via region is formed in said second portion of said dielectric layer; and

[etching said exposed dielectric layer and said dense region simultaneously under the masking of said second patterned photoresist until a portion of said substrate is exposed; and]

removing said second patterned photoresist to form said dual damascene opening having said trench region and said via region.

62. (Amended) The method according to claim 51, wherein said etching process comprises [the] an etching selectivity between said dense region and said dielectric layer is about 2.